Lesson #16: Separation of Variables (Cartesian Coordinates) **Name:** _____

Section 3.3 is one of the most important sections in the course text, at least in terms of your mathematical background. Note from the syllabus that we are spending four lessons on this one section! Not only is it important for Physics 361, but it is also at the heart of quantum mechanics, which you will take next year. It is well worth your time to study this section until you have a firm grasp of the material. For Lesson 16, take a good look at Example3.3, then answer the following questions.

1. Explain why the separated terms in Eq. 3.25 $\left(\frac{1}{X}\frac{\partial^2 X}{\partial x^2} \text{ and } \frac{1}{Y}\frac{\partial^2 Y}{\partial y^2} \right)$ must each equal a constant.

2. The differential equations for $X(x)$ and $Y(y)$ shown in Eq. 3.26 look very similar yet have radically different solutions. Explain why.

3. Explain why, in Eq. 3.26, we must choose a positive constant for the x-equation and a negative constant for the y-equation.

4. The author does a great job solving for the separable solution (Eq. 3.28). Why is it necessary to go the extra step and form a linear combination of these solutions (Eq. 3.30)?

5. Suppose the boundary condition at $x = 0$ is $V_0(y) = 3y$. That is, the potential at this boundary varies linearly with position instead of being constant. Explain how you would find the constants C_n appearing in the general solution (Eq. 3.30).